Multi-Functional Stimuli-Responsive Materials

Completed Technology Project (2011 - 2015)

Project Introduction

Supramolecular polymers based on non-covalent interactions can display a wide array of stimuli-responsive attributes. They can be tailored to change shape, actuate or heal in response to an external stimulus such as light or heat. We are aiming to create dynamic covalent polymers which function in a similar manner but replace the non-covalent interactions with reversible covalent bonds. The motivation for this is twofold. First, by replacing the non-covalent interactions with relatively stronger covalent bonds we can create materials which have more robust mechanical properties. Second, by expanding the library of reversible interactions at our disposable, we can create materials with multiple functions through the incorporation of multiple reversible bonds (both covalent and non-covalent). The work will first focus on synthesizing candidate polymers by drawing analogy to several supramolecular polymers where the supramolecular binding units are replaced with disulfide bonds, which have been proven to be reversible under a number of conditions. The next generation of materials will be prepared that use a combination of disulfide bonds, reversible metal-ligand coordination and liquid crystallinity to access stimuli-responsive materials that exhibit a different response depending on the type of stimulus applied. Mechanical testing would then be employed to assess the efficacy of these polymers as healable, shape memory or actuating materials. The work aims to satisfy some of the objectives set forth in NASA Technology Area 10.1 and 12.1 which call for the development of multi-functional materials with shape memory and self-healing properties.

Anticipated Benefits

Supramolecular polymers based on non-covalent interactions can display a wide array of stimuli-responsive attributes. They can be tailored to change shape, actuate or heal in response to an external stimulus such as light or heat. We are aiming to create dynamic covalent polymers which function in a similar manner but replace the non-covalent interactions with reversible covalent bonds. The motivation for this is twofold. First, by replacing the non-covalent interactions with relatively stronger covalent bonds we can create materials which have more robust mechanical properties. Second, by expanding the library of reversible interactions at our disposable, we can create materials with multiple functions through the incorporation of multiple reversible bonds (both covalent and non-covalent). The work will first focus on synthesizing candidate polymers by drawing analogy to several supramolecular polymers where the supramolecular binding units are replaced with disulfide bonds, which have been proven to be reversible under a number of conditions. The next generation of materials will be prepared that use a combination of disulfide bonds, reversible metal-ligand coordination and liquid crystallinity to access stimuli-responsive materials that exhibit a different response depending on the type of stimulus applied. Mechanical testing would then be employed to assess the efficacy of these polymers as healable, shape

Project Image Multi-Functional Stimuli-Responsive Materials

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

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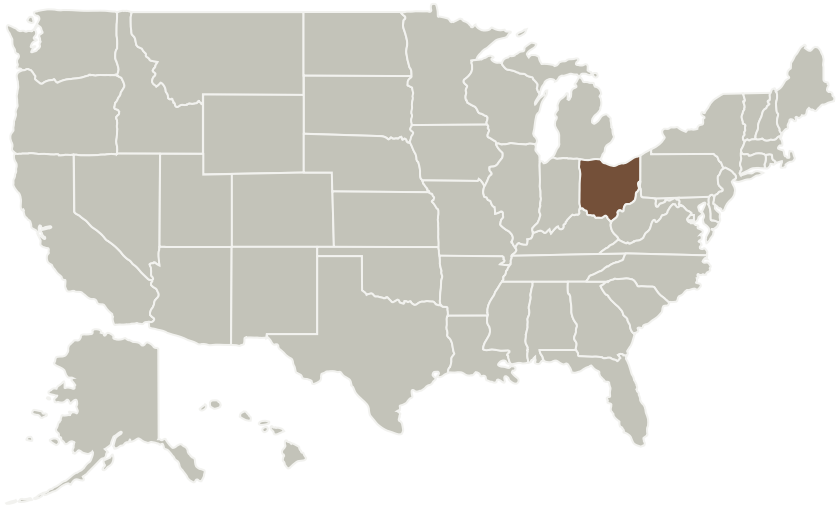
memory or actuating materials. The work aims to satisfy some of the objectives set forth in NASA Technology Area 10.1 and 12.1 which call for the development of multi-functional materials with shape memory and self-healing properties.

Primary U.S. Work Locations and Key Partners



Primary U.S. Work Locations
Ohio

Project Management

Program Director:
Claudia M Meyer

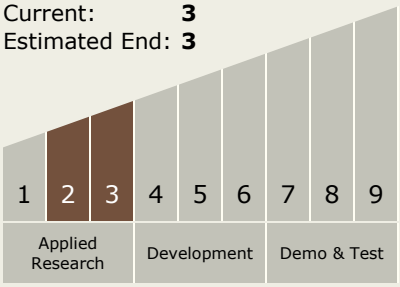
Program Manager:
Hung D Nguyen

Principal Investigator:
Stuart Rowan

Co-Investigator:
Brian T Michal

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.7 Special Materials

Images

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Project Image Multi-Functional Stimuli-Responsive Materials
(https://techport.nasa.gov/image/1801)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html